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(71) Applicant: OSTEONICS CORP.
59 Route 17
Allendale New Jersey 07401(US)

(72) Inventor: Figgie, Harry E. III
30150 Edgewood Drive
Pepper Pike, Ohio 44124(US)
Inventor: Zarnowski, Alfred J.
362 West End Avenue
North Plainfield, New Jersey 07603(US)
Inventor: Lyons, Matthew V.
370 62nd Boulevard Apt. 6,
Gainesville, Florida 32601,(US)

(74) Representative: Jones, Michael Raymond et al
HASELTINE LAKE & CO. Hazlitt House 28
Southampton Buildings Chancery Lane
London WC2A 1AT(GB)

(54) Dual-radius acetabular cup component.

(57) An acetabular cup has a shell component (12) with an outer surface including a first spherical surface portion (22) and a second spherical surface portion (24), and an acetabulum is prepared with an inner surface having a spherical configuration complementary to the second spherical surface portion (24) of the shell component (12), the radius of the first spherical surface portion (22) being slightly greater than the radius of the second spherical surface portion (24) such that upon nesting of the second spherical surface portion (24) of the shell component (12) in contiguous relationship with the inner surface of the acetabulum, the first spherical surface portion (22) engages the inner surface of the acetabulum in an interference fit to secur the shell component (12) within the prepared acetabulum.

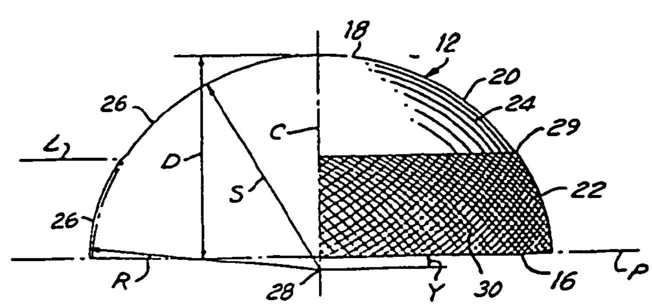

FIG. 2

EP 0 381 351 A1

DUAL-RADIUS ACETABULAR CUP COMPONENT

The present invention relates generally to prosthetic implant devices and pertains, more specifically, to an acetabular cup component to be implanted within the acetabulum. Acetabular cups routinely are employed to replace the socket provided by the natural acetabulum in the implant of hip joint prostheses. The securement of the acetabular cup within the bone of the hip joint has been accomplished through the use of cement. The shortcomings of the various available cements are well-documented and it would be advantageous to have available a construction enabling an acetabular cup to be implanted and fixed within the acetabulum without the use of cement.

One such construction is disclosed in United States Patent Number 4,704,127, wherein there is illustrated an acetabular cup having a dual-geometry outer surface configuration, including a generally frusto-conical surface portion and a generally spherical surface portion. The method of implanting the acetabular cup requires a two-step preparation of the acetabulum to provide both a spherical surface portion and a frusto-conical surface portion along the acetabulum for the reception of the corresponding surface portions of the acetabular cup component. Further, once the acetabulum is prepared to receive the acetabular cup component, the angular orientation of the central axis of the cup is fixed; that is, the accuracy of the angular orientation of the central axis of the implanted acetabular cup component is determined by the accuracy of the orientation of the instruments employed in the preparation of the acetabulum. Thus, it becomes more important that the surgeon exercise extreme care to assure proper orientation of the cutting instruments during preparation of the acetabulum.

According to one aspect of the present invention, there is provided a shell component for use in an acetabular cup assembly of a prosthetic joint, the shell component having a dual-radius outer surface contour conf igured for implant into an acetabulum and securement therein by an interference fit, the shell component having:
a lower rim;
an apical region spaced upwardly in an axial direction a given distance from the lower rim;
an intermediate location located between the lower rim and the apical region; and
an outer surface having a first generally spherical surface portion extending upwardly from the lower rim to the intermediate location, and a second generally spherical surface portion extending upwardly from the intermediate location to the apical region, the first g nerally spherical surface portion having a radius slightly greater than the radius of the second generally spherical surface portion.

According to another aspect of the present invention, there is provided an acetabular cup having a unitary dual-radius outer surface contour configuration for implant into an acetabulum and securement therein by an interference fit, the acetabular cup having a lower rim, an apical region spaced upwardly in an axial direction a given distance form the lower rim, an intermediate location located between the lower rim and the apical region, and an outer surface extending between the lower rim and the apical region, the outer surface contour configuration comprising:
a first generally spherical surface portion extending upwardly between the lower rim and the intermediate location; and
a second generally spherical surface portion extending upwardly between the intermediate location and the apical region;
the first generally spherical surface portion having a radius slightly greater than the radius of the second generally spherical portion.

Preferably the intermediate location is spaced approximately half the distance between the lower rim and the apical region.

Preferably the difference between the radius of the first generally spherical surface portion of the shell component and the radius of the second generally spherical surface portion of the shell component is approximately 0.5 mm.

Preferably the first generally spherical surface portion of the shell component includes an affixation-assisting surface treatment.

Preferably the shell component or acetabular cup has a central axis and the origin of the radius of the first generally spherical surface portion of the shell component is located on the central axis, spaced downwardly in an axial direction from the lower rim.

Preferably the origin of the radius of the second generally spherical surface portion of the shell component is coincident with the origin of the radius of the first generally spherical surface portion of the shell component.

The present invention provides an acetabular cup component with an outer surface configuration which enables implant and securement without the use of cement or another adhesive, and do s so with increased efficacy over commonly available spherical acetabular cup components, while requiring a reduced number of steps in the implant procedure and rendering the angular orientation of the surgical cutting instruments less critical than in the aforesaid dual-geometry acetabular cup component. Accordingly, the present sinvention accom-

plishes several objects and advantages, some of which may be summarized as follows: provides an acetabular cup component capable of being implanted and secured in place without the use of cement or another adhesive, utilizing a simplified implant method; provides an acetabular cup component capable of being implanted and secured in place with an interference fit; enables simplification of the preparation of the acetabulum with less invasion of the bone of the acetabulum; reduces the criticality of the angular orientation of the cutting instruments employed to prepare the acetabulum for implant, while still realizing the advantages of an interference fit between the acetabular cup component and the acetabulum; enables a quicker preparation of the acetabulum without sacrificing efficacy; places the interference fit at a preferred location within the bone available in the acetabulum while attaining congruity between the acetabular cup component and the prepared acetabulum essentially along the entire prepared acetabular surface, thus achieving appropriate bone apposition for proper implant affixation; enables a cup configuration of simplified design and construction for ease of manufacture with precision and reliability; enables a rugged construction in an acetabular cup component for reliable service over a long service life.

The invention will be understood more fully, while still further objects and advantages will become apparent, in the following detailed description of a preferred embodiment of the invention illustrated in the accompanying drawing, in which:

FIG. 1 is an exploded perspective view of an acetabular cup assembly including a shell component constructed in accordance with the present invention;

FIG. 2 is an enlarged, partially diagrammatic, elevational view of the shell component;

FIG. 3 is an illustration of a portion of a hip bone showing the preparation of the acetabulum for reception of the shell component; and

FIG. 4 is an illustration similar to FIG. 3, but showing the implant and securement of the shell component.

Referring now to the drawing, and especially FIG. 1 thereof, an acetabular cup assembly 10 is shown having a shell component 12 constructed in accordance with the invention, and a bearing component in the form of bearing insert 14. Initially, the shell component 12 will be implanted and secured within the acetabulum, as will be explained below, and the bearing insert 14 will be assembled with the shell component 12, interoperatively (that is during surgery) , in the manner described in United States Patent Number 4,695,282.

As best seen in FIG. 2, as well as in FIG. 1, shell component 12 includes a lower rim 16, and an apical region or top 18 spaced upwardly in an axial direction a given distance D from the lower rim 16. The outer surfac 20 of the shell component 12 includes a first or lower generally spherical surface portion 22 and a domed, second or upper generally spherical surface portion 24 which, together, establish a unique dual-radius surface contour 26 along the outer surface 20 of the cup component 12.

The lower spherical surface portion 22 extends upwardly along an essentially continuous profile, as depicted diagrammatically at the left side of FIG. 2, from the lower rim 16 to a location L spaced upwardly from the rim 16 about one-half the distance D between the rim 16 and the top 18. The upper spherical surface portion 24 extends upwardly from the intermediate location L to the top 18. The lower spherical surface portion 22 has a radius R measured from an origin 28 located on the central axis C of the shell component 12 and spaced downwardly a short distance Y from the plane P of lower rim 16 so that the origin 28 is located outside the envelope of the shell component 12. Upper spherical surface portion 24 has a radius 5 measured from an origin coincident with origin 28. Radius R of the lower spherical surface portion 22 is slightly greater than radius S of the upper spherical surface portion 24, and a smooth transition is provided between the lower and upper spherical surface portions 22 and 24 in the vicinity of intermediate location L, as seen at 29. Lower spherical surface portion 22 preferably is knurled, as indicated at 30, or is provided with an alternate affixation-assisting surface treatment, for purpos s which will be described more fully hereinafter.

Referring now to FIG. 3, the acetabulum 40 of a hip bone 42 has been provided with a surface contour for the reception of shell component 12. Thus, acetabulum 40 is prepared by forming an inner spherical surface 44, as by reaming with a spherical reamer (not shown) to the full desired depth D' of the acetabulum. Spherical surface 44 is provided with a radius S' which is essentially equal to radius S of the upper spherical surface portion 24 of the outer surface 20 of the shell component 12. Thus, the radius S' at the mouth 50 of the prepared acetabulum 40 is slightly smaller than the radius R of the lower spherical surface 22 of shell component 12. Depth D' is essentially equal to distance D of the shell component 12.

It is noted that in the surgical environment the preparation of the acetabulum 40 is carried out with hand-held instruments, so that ordinarily it is difficult to maintain the desired precision in the relationship between the surfaces of the prepared acetabulum and the shell component to be implanted in the prepared acetabulum. In particular, it is necessary to assure that the central axis C of the shell

component 12 will be oriented properly with respect to the hip bone 42 when the shell component 12 is seated within the acetabulum 40, and that orientation usually must be taken into account during preparation of the acetabulum. However, since the inner surface of the acetabulum 40 is the spherical surface 44, the orientation of the spherical reamer which prepares spherical surface 44 is independent of the orientation of tile seated cup component 12 and the preparation of the acetabulum 40 is simplified. That is, the hand-held spherical reamer may be held at any angular orientation during preparation of the spherical surface 44 without affecting the ultimate orientation of the implanted cup component 12, so that orientation of the reamer is not critical, thereby facilitating preparation of the acetabulum 40.

Turning now to FIG. 4, shell component 12 initially is placed in the prepared acetabulum 40 in the position shown in phantom, with the upper spherical surface portion 24 of outer surface 20 within the acetabulum 40 and the lower spherical surface portion 22 against the mouth 50 of the acetabulum 40. Subsequently, the shell component 12 is impacted into the acetabulum 40, utilizing available surgical instruments provided for that purpose, as illustrated in full lines, to achieve a tight, stable interference fit by virtue of the relative dimensions of the lower spherical surface portion 22 of the outer surface 20 of the shell component 12 and the spherical surface 44 of the acetabulum 40 at the acetabular rim 52 adjacent the mouth 50. At the same time, the upper spherical surface portion 24 and spherical surface 44 are placed in a contiguous nested relationship to attain the desired apposition between the shell component 12 and the acetabulum 40. The implant procedure is facilitated and the desired apposition is attained more readily by the dual-radius configuration of the outer surface 20, which configuration provides a relatively smooth transition between the lower spherical surface portion 22 and the upper spherical surface portion 24 in the vicinity of intermediate location L.

It is noted that the lower spherical surface portion 22 of the cup component 12 is located in the acetabular rim 52 upon completion of the implant. Thus, the interference fit between the cup component 12 and the acetabulum 40 is placed within a region of optimal bone structure for the accommodation of the interference fit. At the same time, the desired apposition between the upper spherical surface portion 24 and the prepared acetabulum 40 is attained by virtue of the congruity achieved by the fact that radius S and radius S′ are equal. The shell component 12 is secured within the acetabulum 40 against rotation about the axial direction, against axial displacement and against rocking movements. The configuration of the outer surface contour 26 of sh ll component 12 assures such firm securement while requiring only minimal bone removal in the preparation of the acetabulum 40. The knurled or other affixation-assisting surface treatment at 30 assists in fixing the shell component 12 in place. A further affixation-assisting surface treatment (not shown) may be provided along the upper spherical surface portion 24 to assist in attaining affixation along the nested surfaces of the cup component 12 and the acetabulum 40. In addition, location of the lower spherical surface portion 22 of the shell component 12 within the acetabular rim 52 provides a transfer of the load placed on the shell component 12 resembling the natural load transfer.

Shell component 12 is manufactured in a range of sizes. Typically, the diameter of the spherical surface 44 will range from about 40 mm to 72 mm. It has been found that a difference of only about 0.5 mm between the radius R of the lower spherical surface portion 22 and the radius S of the upper spherical surface portion 24, when employed in combination with an acetabulum 40 within the range of the aforesaid dimensions, is sufficient to accomplish an interference fit having the qualities outlined above without introducing deleterious or intolerable stress in the surrounding bone structure. It is noted that the term "approximately one-half the distance D" as employed to define the axial extent of the lower spherical surface portion 22 relative to the axial extent of the upper spherical surface portion 24
denotes the ability to depart slightly from the nominal one-half the distance D while still attaining adequate performance.

Claims

1. A shell component for use in an acetabular cup assembly of a prosthetic joint, the shell component having a dual-radius outer surface contour configured for implant into an acetabulum and securement therein by an interference fit, the shell component having:
a lower rim;
an apical region spaced upwardly in an axial direction a given distance from the lower rim;
an intermediate location located between the lower rim and the apical region; and
an outer surface having a first generally spherical surface portion extending upwardly from the lower rim to the intermediate location, and a second generally spherical surface portion extending upwardly from the intermediate location to the apical region, the first generally spherical surface portion having a radius slightly greater than the radius of the second generally spherical surface portion.

2. A shell component according to Claim 1, wh rein the int rmediate location is spaced approximately half the distance between the lower rim and the apical region.

3. A shell component according to claim 1 or 2, wherein the difference between the radius of the first generally spherical surface portion of the shell component and the radius of the second generally spherical surface portion of the shell component is approximately 0.5 mm.

4. A shell component according to claim 1, 2 or 3, wherein the first generally spherical surface portion of the shell component includes an affixation-assisting surface treatment.

5. A shell component according to any preceding claim, wherein the shell component has a central axis and the origin of the radius of the first generally spherical surface portion of the shell component is located on the central axis, spaced downwardly in an axial direction from the lower rim.

6. A shell component according to claim 5, wherein the origin of the radius of the second generally spherical surface portion of the shell component is coincident with the origin of the radius of the first generally spherical surface portion of the shell component.

7. An acetabular cup having a unitary dual-radius outer surface contour configuration for implant into an acetabulum and securement therein by an interference fit, the acetabular cup having a lower rim, an apical region spaced upwardly in an axial direction a given distance from the lower rim, an intermediate location located between the lower rim and the apical region, and an outer surface extending between the lower rim and the apical region, the outer surface contour configuration comprising:
a first generally spherical surface portion extending upwardly between the lower rim and the intermediate location; and
a second generally spherical surface portion extending upwardly between the intermediate location and the apical region;
the first generally spherical surface portion having a radius slightly greater than the radius of the second generally spherical portion.

8. An acetabular cup according to claim 7, wherein the intermediate location is spaced approximately half the distance between the lower rim and the apical region.

9. An acetabular cup according to claim 7 or 8, wherein the difference betw en the radius of the first generally spherical surface portion of the shell component and the radius of the second generally spherical surface portion of the shell component is approximately 0.5 mm.

10. An acetabular cup according to claim 7, 8 or 9, wherein the first generally spherical surface portion of the shell component includes an affixation-assisting surface treatment.

11. An acetabular cup according to any one of claims 7 to 10, wherein the acetabular cup has a central axis and the origin of the radius of the first generally spherical surface portion of the acetabular cup is located on the central axis, spaced downwardly in an axial direction from the lower rim.

12. An acetabular cup according to claim 11, wherein the origin of the radius of the second generally spherical surface portion of the acetabular cup is coincident with the origin of the radius of the first generally spherical surface portion of the acetabular cup.

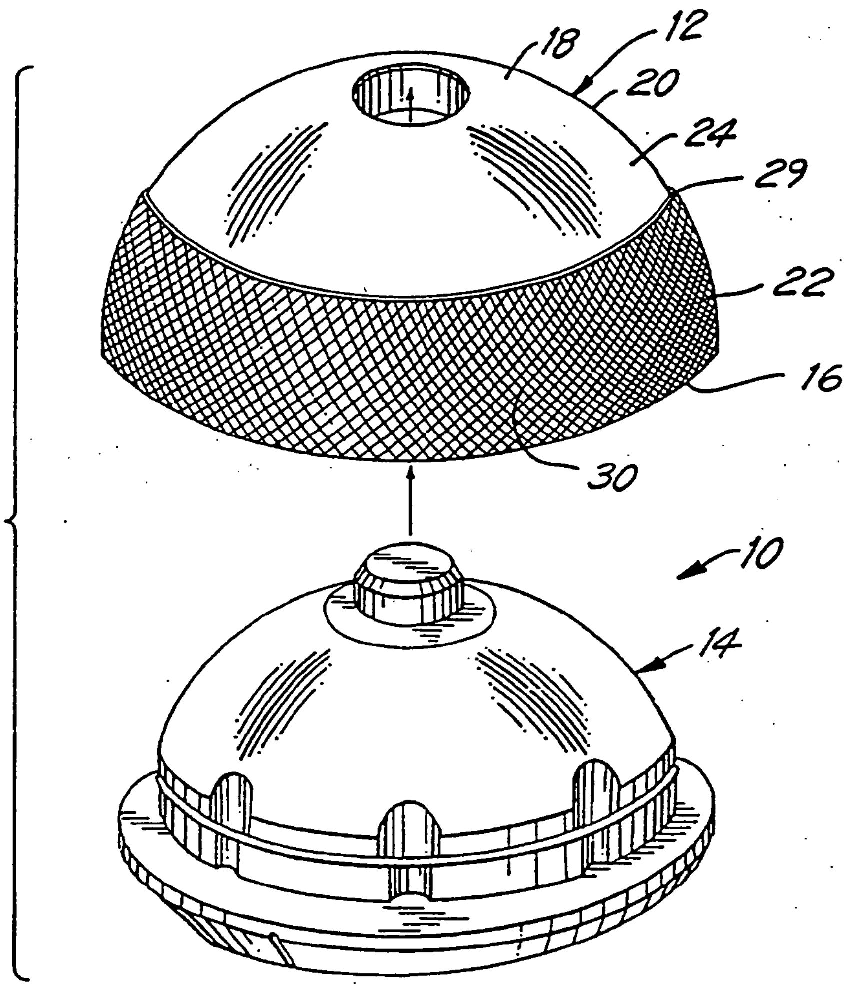

FIG. 1

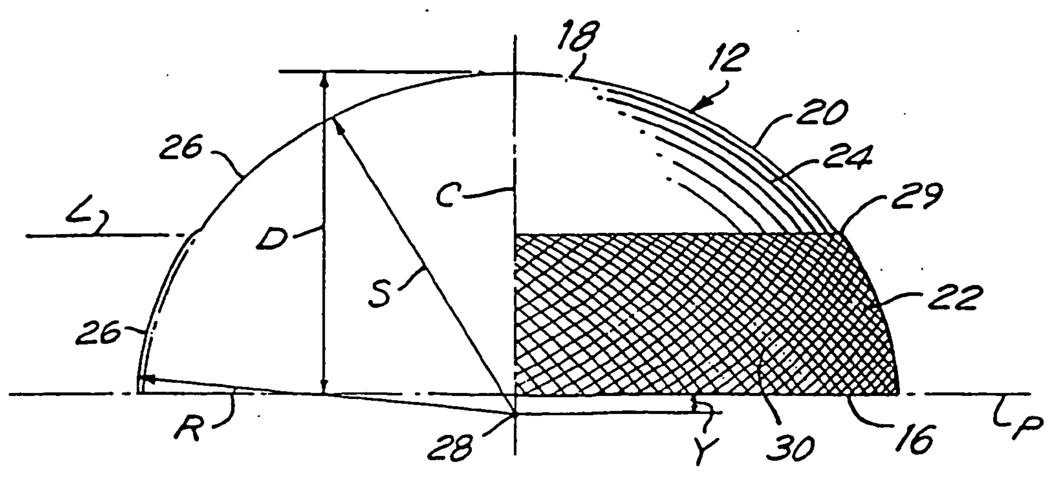

FIG. 2

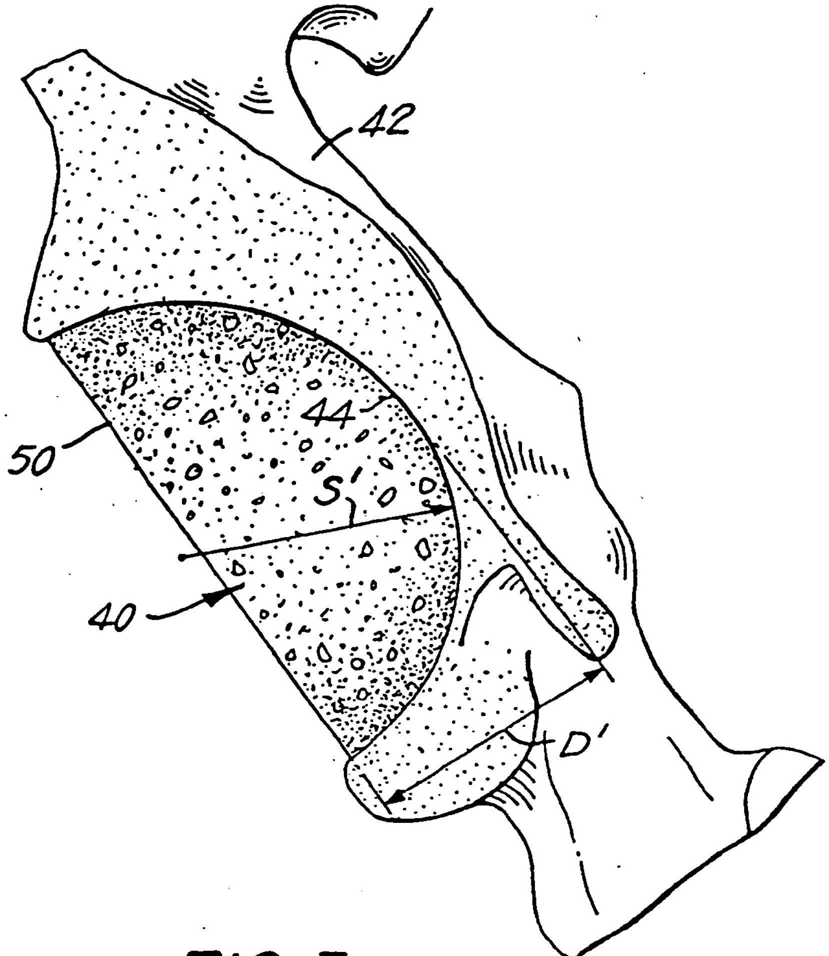

FIG. 3

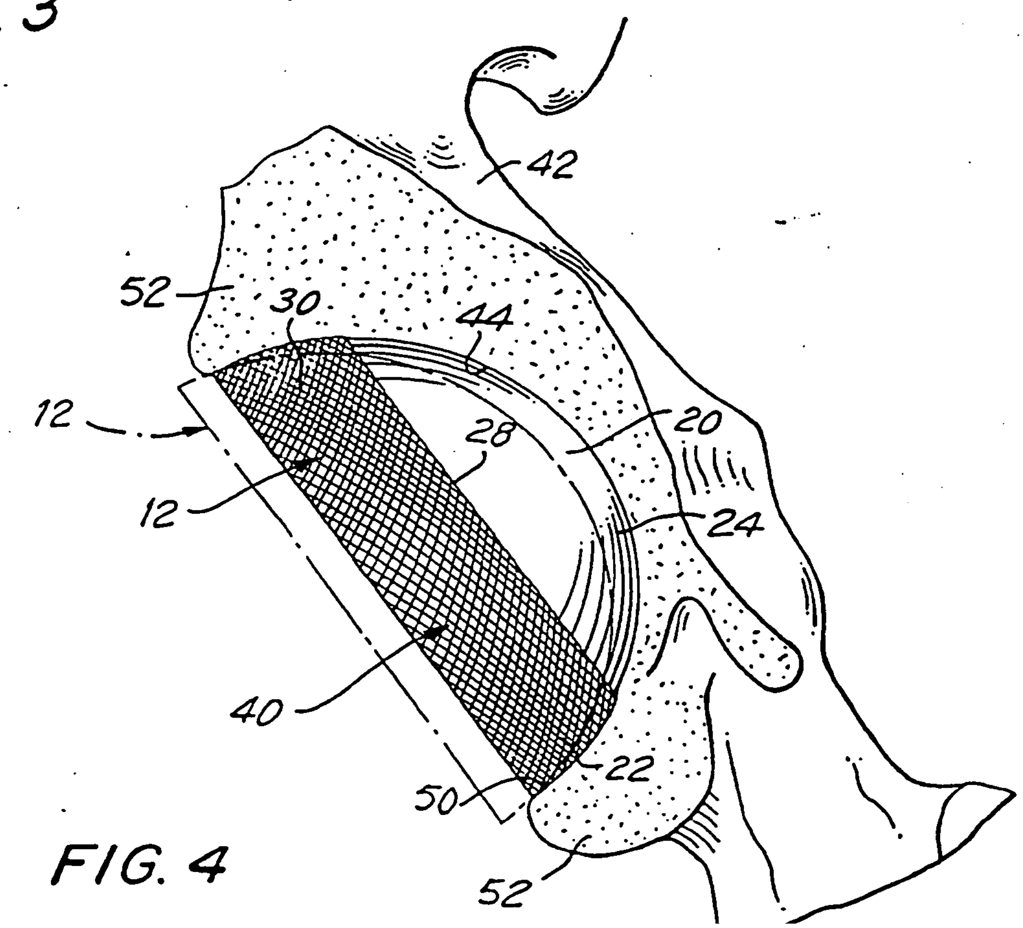

FIG. 4

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 90 30 0672

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
D,A	US-A-4 704 127 (AVERILL) * Abstract; figures; column 3, line 47 - column 4, line 28 * ---	1	A 61 F 2/34
A	DE-A-3 341 723 (SANZ) ---		
A	FR-A-2 590 478 (LAHILLE) ---		
A	EP-A-0 291 562 (SULZER) ---		
A	EP-A-0 065 482 (MECRON) -----		
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			A 61 F

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	07-05-1990	STEENBAKKER J.

CATEGORY OF CITED DOCUMENTS

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